CLAIMS

1. A vertical cavity surface emitting laser comprising:

a first mirror region forming a first distributed Bragg reflector;

a first cladding region positioned on the first mirror region;

an active region positioned on the first cladding region;

a second cladding region positioned on the active region and including a high electrical resistance implanted region positioned to define a current path;

a second mirror region positioned on the second cladding region;

a current spreading region positioned on the second mirror region;

a first electrical contact in electrical communication with the current spreading region and a second

electrical contact positioned to conduct electrical current in circuit with the first electrical contact through the current path;

the current spreading region and the second mirror region cooperating to produce substantially uniform current distribution in the current path; and

a third mirror region positioned on the current spreading region, the second and third mirror regions cooperating to provide a complete distributed Bragg reflector.

2. A vertical cavity surface emitting laser as claimed in claim 1 wherein the first mirror region, the first cladding region, the active region, the second cladding region, the second mirror region, and the current spreading region include epitaxial semiconductor layers.

3. A vertical cavity surface emitting laser as claimed in claim 1 wherein the high electrical resistance implanted region includes ion implanted material.

4. A vertical cavity surface emitting laser as claimed in claim 1 wherein the second mirror region includes from one to five pairs of alternate mirror layers of a first material with a first index of refraction and a second material with a second index of refraction.

5. A vertical cavity surface emitting laser as claimed in claim 1 wherein the current spreading region includes at least one highly doped semiconductor layer.

6. A vertical cavity surface emitting laser as claimed in claim 1 wherein the third mirror region includes a plurality of pairs of one of alternate semiconductor layers and alternate dielectric layers.

7. A vertical cavity surface emitting laser as claimed in claim 1 further including an index guide formed in the current spreading region.

8. A vertical cavity surface emitting laser as claimed in claim 1 further including a notch formed in the first

mirror region to limit a diameter to approximately a primary mode of operation.

9. A vertical cavity surface emitting laser as claimed in claim 1 further including a tunneling junction.

10. A vertical cavity surface emitting laser comprising:

a first mirror region forming a first distributed Bragg reflector;

a first cladding region positioned on the first mirror region;

an active region positioned on the first cladding region;

a second cladding region positioned on the active region and including a high electrical resistance ion implanted region positioned to define a current path;

a second mirror region positioned on the second cladding region including from one to five pairs of alternate mirror layers of a first semiconductor material with a first index of refraction and a second semiconductor material with a second index of refraction;

a current spreading region including a heavily doped semiconductor layer positioned on the second mirror region;

an index guide formed in the current spreading region, the index guide defining a lasing cavity;

a first electrical contact in electrical communication with the current spreading region and a second electrical contact positioned to conduct electrical current in circuit with the first electrical contact through the current path;

the current spreading region and the second mirror region cooperating to produce substantially uniform current distribution in the current path; and

a third mirror region positioned on the current spreading region, the second and third mirror regions cooperating to provide a complete distributed Bragg reflector.

11. A vertical cavity surface emitting laser as claimed in claim 10 wherein the third mirror region includes a plurality of pairs of one of alternate semiconductor layers and alternate dielectric layers.

12. A method of fabricating a high frequency vertical cavity surface emitting laser comprising the steps of:

providing a substrate;

growing a first mirror region on the substrate, a first cladding region on the first mirror region, an active region on the first cladding region, a second cladding region on the active region, a second mirror region on the second cladding region, and a current spreading region overlying the second mirror region;

implanting ions into a portion of the second cladding region, through the second mirror region and current spreading region to define a current path;

forming a third mirror region on the current spreading region, the third mirror region and the second mirror region cooperating to provide a complete distributed Bragg reflector; and

forming a first electrical contact in electrical communication with the current spreading region and a second electrical contact positioned to conduct electrical current in circuit with the first electrical contact through the current

path, the current spreading region and the second mirror region cooperating to produce substantially uniform current distribution in the current path.

13. A method as claimed in claim 12 wherein the step of growing includes epitaxially growing.

14. The method of claim 12 wherein the step of growing includes growing the first mirror region to form a complete distributed Bragg reflector.

15. The method of claim 12 wherein the step of growing includes growing the second mirror region to include from one to five pairs of alternate mirror layers of a first material with a first index of refraction and a second material with a second index of refraction.

16. A method as claimed in claim 12 wherein the step of growing the current spreading region includes growing at least one highly doped semiconductor layer.

17. A method as claimed in claim 12 wherein the step of forming the third mirror region includes a growing plurality of pairs of one of alternate semiconductor layers and alternate dielectric layers.

18. A method as claimed in claim 12 wherein the step of forming the second electrical contact includes depositing a metal contact layer on a rear surface of the substrate.

19. A method as claimed in claim 12 wherein the step of forming the second electrical contact includes growing a second current spreading region between the first cladding region and the first mirror region during the step of growing the first cladding region on the first mirror region, etching a portion of the laser to expose a surface of the second current spreading region, and depositing a metal contact layer on the exposed surface.

20. A method as claimed in claim 12 wherein the step of implanting ions includes implanting at least one of hydrogen ions and helium ions.

21. A method as claimed in claim 12 wherein the step of implanting ions includes implanting the ions to a depth in a range of 1000 Angstroms to 10,000 Angstroms.

22. A method as claimed in claim 12 including a step of growing a tunneling junction between the second mirror region and the current spreading region during the step of growing the current spreading region.

23. A method of fabricating a high frequency vertical cavity surface emitting laser comprising the steps of:

providing a substrate;

epitaxially growing a first mirror region on the substrate forming a complete distributed Bragg reflector;

epitaxially growing a first cladding region on the first mirror region;

epitaxially growing an active region on the first cladding region;

epitaxially growing a second cladding region on the active region;

epitaxially growing a second mirror region on the second cladding region including from one to five pairs of alternate mirror layers of a first material with a first index of refraction and a second material with a second index of refraction;

epitaxially growing a heavily doped current spreading region overlying the second mirror region;

implanting ions into a portion of the second cladding region, through the second mirror region and current spreading region to define a current path;

forming a third mirror region on the current spreading region, the third mirror region and the second mirror region cooperating to provide a complete distributed Bragg reflector; and

forming a first electrical contact in electrical communication with the current spreading region and a second electrical contact positioned to conduct electrical current in circuit with the first electrical contact through the current

path, the current spreading region and the second mirror region cooperating to produce substantially uniform current distribution in the current path.

24. A method as claimed in claim 23 wherein the step of implanting ions includes implanting at least one of hydrogen ions and helium ions.

25. A method as claimed in claim 23 wherein the step of implanting ions includes implanting the ions to a depth in a range of 1000 Angstroms to 10,000 Angstroms.

26. A method as claimed in claim 12 including a step of epitaxially growing a tunneling junction between the second mirror region and the current spreading region during the step of growing the current spreading region.